ABSTRACT

METHOD OF SEPARATION OF PALLADIUM ISOTOPES IN ELECTROMAGNETIC SEPARATOR USING A SOURCE OF IONS

The invention relates to the technology of electromagnetic separation of palladium isotopes.

The method provides placement of a working substance comprised by metal palladium in a combined with gas-discharge chamber crucible of a source of ions, heating of the working substance up to the vapor state, ionization of the vapors of the working substance in the gas-discharge chamber of the source under action of electron emission from a hot cathode, forming ionic beam by electrodes of ion-optical system, separation and focusing the ionic beams of isotopes in magnetic field, entrapping the ions by receiving boxes, thus temperature of the crucible heating and the gas-discharge chamber being maintained within 1500-1700°C.

The method being effectively used for industrial electromagnetic palladium isotope separation and for obtaining isotopes: Pd-102, Pd-104, Pd-105, Pd-106, Pd-108 b Pd-110 with higher enrichment degree.

Field of the invention FIELD OF THE INVENTION

The present invention relates to the technology of electromagnetic separation of isotopes of chemical elements and, particularly, to electromagnetic separation of palladium isotopes.

The present invention can be most effectively used for industrial electromagnetic separation of stable palladium isotopes: palladium-102, palladium-104, palladium-105, palladium-106, palladium-108, and palladium-110.

Background of the invention BACKGROUND OF THE INVENTION

It is A known a method of separation of isotopes of heats chemical elements used for industrial electromagnetic separation of isotopes providing heating of in a crucible with working substance and of a gas-discharge chamber by thermal radiation of active resistance heaters, to ionization of molecules of the working substance in the gas-discharge chamber,. The ions being extracted therefrom and are formed into an ionic beam being that is separated and focused by a magnetic field according to the mass of the ion isotopes and entrapped by receiving boxes. See, (N.A. Kascheev, V.A. Dergatchev. "Electromagnetic separation of isotopes and isotopic analysis". Moscow, "Energoatomizdat", 1989).

Deficiency of the stated method is in that it has low efficiency of separation of the elements of platinum-palladium group.

The method described in the work (by V.P. Botchin, B.E. Gavrilov, and V.S. Zolotariov. in "Isotopenpraxis" Heft 6 (1971) 232) is the closest on technical essence known method of industrial separation of palladium isotope in electromagnetic separator with use of a source of ions.

The method of separation of palladium isotopes described in the cited reference consists is in the following. Vapors of the working substance being are formed during heating at temperatures up to 1000°C in a crucible of the source in

result of from a reaction of metal powder palladium and fluorine gas fed into the crucible through an in-leakage system. The iIons being are formed in the vapors of the working substance in the gaseous chamber of the source under by action of electron emission of a hot cathode where they being drawn from and formed into an ionic beam by electrodes of an ion-optical system. In the process of passing through the being pumped out through a separating chamber the ionic beams of palladium isotopes being are separated in a static magnetic field depending on mass of isotopes (Pd-102, Pd-104, Pd-105, Pd-106, Pd-108 and Pd110), being focused by this field and entrapped by the relevant receiving boxes.

DA drawback of the known method of palladium isotope separation in such electromagnetic separators with use of a source of ions is in that the technical result is unsatisfactory because of low enrichment of entrapped isotopes due to dispersion of the isotope ion beams on molecules of the residual gas, mainly fluorine, not reacted with metal palladium. Besides, presence of an additional parameter -pressure of fluorine - in the source crucible and in the separating chamber considerably complicates selection of focusing modes.

Other deficiencies of the known method are the following:

- necessity to use special constructional materials being corrosion-resistant to action of fluorine;
- special safety measures of protection which is a complicated problem in conditions of industrial manufacture.

SUMMARY OF THE INVENTION

The technical result object of the present invention is in increasing of the enrichment of separated palladium isotopes.

Summary of the invention

The stated object is achieved by that using metal palladium being used as the working substance. This working substance is not hygroscopic, feebly reacts with constructional materials and creates pressure vapors sufficient for maintaining a steady arc discharge in the temperature span from 1500 to 1700°C. The use of metal palladium (in the form of powder, sponge, ingot etc.) as the working substance allowed to obtain provides good focusing of ionic beams in manufactureing conditions and to increases enrichment of separated palladium isotopes.

A method of electromagnetic separation of palladium isotopes places a working substance of metal palladium in a gas-discharge chamber crucible with a source of ions. The working substance is heated to vapors, the vapors of the working substance ionized in the gas-discharge chamber under the action of electron emission from a hot cathode, and ionic beams formed by electrodes of an ion-optical system. The ionic beams separate the isotopes in a magnetic field, entrapping the ions in receiving boxes, the temperature of the gas-discharge chamber being maintained within 1500-1700°C. The method is effectively used for separation of isotopes Pd-102, Pd-104, Pd105, Pd-106, Pd-108 b Pd-110 with a high enrichment degree.

BRIEF DESCRIPTION OF THE DRAWING

The drawing shows a schematic elevation, partly in section, of an exemplary embodiment.

DESCRIPTION OF EXEMPLARY EMBODIMENT

An exempleplary of embodiment of the method of palladium isotope separation in an electromagnetic separator with use of a source of ions is presented below for explanation of the invention. One of separating chambers (at 2 in the Fig.) of the industrial electromagnetic separator "SU-20" - production of the industrial complex "Electrohimpribor", Russia - was used for the experiment. A weighed portion of spongy metal palladium was placed in a graphite crucible 4 combined with a gas-discharge chamber 5 of the an ions source 1. After installation of the source and a six-boxes receiver 10 in the inside 7 of the walls 8 of the separating chamber of at 2 the separator the separating chamber was pumped-out by vacuum pumps through an outlet 11 up to the pressure $(1\text{-}2)\cdot10^{-3}$ Pa and the source was high-voltage trained of up to voltage 33-35 kV.

To obtain an electron beam in the gas-discharge chamber of the source the cathode block- was applied voltages ensuring: filament current - 70-80 A, voltage between filament and hot cathode - 0.8-1.0 kV, emission current - 0.5-0.6 A. At current of arc discharge 0.5-1.5 A and voltage of discharge 150-350 V ionization. was carried out of the vapors of working substance .formed at power of crucible heater of 2500 - 4000 W.

Formed palladium ions were drawn out through a slot of the gas-discharge chamber with help of an ion-optical system and were shaped in an ionic beam which under action of accelerating voltage and static magnetic field of 2600 Oersted in the chamber was separated on six :ionic beams of isotopes according to masses of the ions. These beams of isotopes were focused by the illustrated magnetic field in a focal plane where inlets of the receiver boxes 10 of a receiver 9 were positioned.

After accumulation the receivers were taken out from the separating chamber, isotopes were removed by the method of anodic pickling from the boxes, obtained isotopic enriched solution was analyzed on enrichment and processed to the finished product.

Following isotopes were obtained in the process of experimental-industrial separation on electromagnetic separator "SU-20":

- isotope Pd-102 with enrichment 85.4-92.9 % - 3 g;
- isotope Pd-104 with enrichment 96.6-98.4 % - 34 g;
- isotope-Pd-105 with enrichment 98.4-99.1 % - 65 g;
- isotope Pd-106 with enrichment 99.1-99.5 % - a - 82 g;
- isotope Pd-108 with enrichment 99.4-99.6 % - 86 g;
- isotope Pd-110 with enrichment 99.2-99.5 % - 35 g.

The table represents basic parameters of the method of palladium isotope separation according to the claimed technical solution.

The table

No.	Basic parameters	Clamed technical solution
1.	Source	without inleakage system
2.	Working substance	metal Pd
3.	Arc discharge current, A	0.5-1.5
4.	Arc discharge voltage, V	150-350
5.	Power of crucible heater, W	2500-4000
6.	Pressure in the separating chamber, Pa	$(1\text{-}2)\cdot10^{-3}$
7.	Pd load in crucible, g	15-20
8.	Mean operating time of the source, hours	25-30
9.	Ionic current on the receiver, mA	15-25

The proposed method of palladium isotope separation in electromagnetic separator with use of a source of ions compared with the existing methods showed high performance in obtaining technical and economic result. Use in practice of the claimed technical solution enables to effectively use said method for industrial electromagnetic palladium isotope separation and deriving of isotopes: Pd-102, Pd-104, Pd-105, Pd-106, Pd-108 and Pd-110 with a higher level of enrichment.

Elimination of the fluorination process also permitted to abandonment application of complex security measures at for work with gaseous fluorine, that, at the end, which improves the working conditions of the personnel.